APPARATUS AND METHOD FOR REDUCING OSCILLATOR FREQUENCY PULLING DURING AM MODULATION

RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 60/120,641, filed Feb. 18,1999.

FIELD OF THE INVENTION

The present invention generally relates to radio frequency signal modulation. More specifically, the present invention relates to attenuation of oscillator frequency pulling. Specifically, the invention provides a non-harmonically related frequency scheme to significantly reduce frequency pulling during amplitude modulation of the transmit power with data. More specifically, the invention pertains to the elimination of injection locking between a voltage controlled oscillator (VCO) and an output signal by preferably generating a non-harmonic relationship between the VCO and the output signal.

BACKGROUND OF THE INVENTION

The technique for converting signals to modulate amplitude is well known. Signals may be conditioned or enhanced. Signal conditioning is the process of modifying or adapting a signal to match a specific purpose. For example, a typical system in which signals are conditioned includes the detection and filtering of an alternating-current wave for indirect voltage measurement using a direct current meter. Another example is the implementation of an equalizer in a high-fidelity system. Signal enhancement relates to a process in which the quality of decipherabilty of a signal is improved. For example in radio-frequency (RF) receivers, signal enhancement is implemented to optimize the signal-to-interference ratio. Further, in high-fidelity audio receivers, signal enhancement is used to reduce noise and adapt the sound to a listener's preferences.

Signal processing also utilizes modulation techniques to condition signals. Generally, modulation techniques implement a synthesizer to generate a desired signal. Modulation in general refers to the process of changing the characteristics of an electromagnetic wave in a manner to convey communication or other intelligence. Several difficult aspects of modulation are encountered in the art when more data are required at a rate higher than that allowed by normal modulation.

Traditionally, in order to transfer signals at a high rate of speed, modulation based signal processing techniques employ various complex systems such as up conversions, several filters, synthesizers and oscillators. These systems, to a large extent, encounter frequency pulling and are prone to unreliable and distorted signal output. Specifically, spurious responses from mixing devices contribute to output signal corruptions. Further, prior art systems require significant modifications and upgrade for integration with other multichannel data command units specially if frequency pulling is anticipated. Many synthesized radio units, which implement amplitude modulation, require a better and efficient topology to overcome the aforementioned problems and also to transmit the information contained in the signals at high fidelity and quality.

FIG. **1** is a prior art schematic representing a circuit implemented to reduce frequency pulling. The circuit includes a reference signal source **10** which is connected to a plurality of frequency dividers **11**. The output from each

frequency divider **11** is fed into phase detectors **12**. Each phase detector **12** is connected to low units, which implement amplitude modulation, require a better and efficient pass filter (LPF) **13** on the output side. LPFs **13** are then connected to VCO1 **15***a* and VCO2 **15***b*, respectively. The VCOs, **15***a*, **15***b* produce frequencies which are fed into mixer **16**. A portion of VCO1 **15***a* and VCO2 **15***b* output is fed back into phase detectors **12** via frequency dividers **14**. The output from mixer **16** is directed to pre-transmission filter **17**. Thereafter, the signal is directed through amplifier **18** to antenna **19**. The frequency output at antenna **19** is a sum and or difference of the frequency outputs from VCO1 **15***a* and VCO2 **15***b*.

The prior art utilizes up and down conversion of the signal source to reach an intermediate frequency (IF). The IF is the output frequency from the mixer stage. High gain and only moderate selectivity can be obtained because the high Q factor required on the filters due to the high upconverted frequency.

One of the many limitations of the prior art is that the architecture for reducing carrier frequency pulling is very complex. Specifically, the scheme requires several filters, oscillators and mixers to eliminate spurious and non-related harmonics from the transmitter. However, these components generate local interferences, both individually and in combinations, which further distort the information carried in the signal and the output frequency.

Accordingly there is a need to provide a reliable and efficient circuit to attenuate oscillator frequency pulling including elimination of spurious and providing related harmonic isolation from the output of an amplitude modulated VCO. It turns out that output frequencies which are harmonically related to either VCO1 or VCO2 (15A or 15B) tend to also pull the VCO's frequency as well.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide apparatus and a method in which frequency pulling is significantly eliminated in an output VCO which output is a result of AM modulation. The output frequency is structured to be larger than the synthesizer VCO frequency by a rational (non-integer) factor greater than unity, thus maintaining a non-harmonic relationship between the output VCO and the synthesizer.

Another object of the present invention is to eliminate spurious responses. Spurious responses in a transceiver can take place as a result of mixing between two or more external signals. By making the output exactly 1.5 times the VCO, the mixing spurious which results will lie exactly on the desired carrier, as it applies only in this case.

It is a further object of the invention to provide a scheme in which a synthesizer, a plurality of frequency multipliers, an output VCO, a low pass filter, a mixer, a pretransmission filter and a transmitter are connected in a manner to generate an output frequency which is non-harmonically related to the synthesizer VCO during an AM modulation of the output VCO, in order to avoid frequency pulling of the synthesizer's VCO.

Yet another object of the invention is to provide an AM modulation scheme in which the frequency pulling is substantially reduced. Generally, AM modulation involves a process by which voices and other signals are impressed onto a carrier signal.

It is a further object of the invention to provide a frequency pulling reduction architecture implemented in an AM modulation process wherein spurious response resulting